

FIGURE 5.—Monthly mean temperatures, air and soil, Hallett station, Antarctica, April–December 1958.

and after drift removal. Under the deep snow cover, particularly in July (see July graph, fig. 4), while air temperature was fluctuating widely and erratically, soil temperatures were decreasing at a gradual rate. With the removal of the insulating snow, mean daily soil temperatures, particularly at the 10-cm. level, followed closely the fluctuations of air temperature. During most of the measurement period, the soil temperature curves followed the air temperature curve. Largest deviation occurred in July and the greatest warming took place at the 10-cm. depth. From September on, the trend for air and subsurface temperatures was upward; the mean

monthly air and soil temperature traces then displayed a nearly linear relationship.

The tremendous increase of soil temperatures on November 22 and 23 (see November graph, fig. 4) is attributed, at least in part, to a large pool of snow melt that covered a large area and then rapidly drained into the subsoil. After this upward surge of soil temperature, the daily mean for both levels generally remained higher than the daily mean air temperature.

4. CONCLUDING REMARKS

This project was an interesting sideline to the regularly programmed schedule of observations and necessitated some improvisation to secure accurate data. It provides, in general, some knowledge of the temperature regime to be found in Antarctic soil. In addition, a first approximation of the depth of permafrost in the Cape Hallett area is provided. With data available on solar radiation, these temperatures may provide extra material for heat budget studies.

ACKNOWLEDGMENTS

The author wishes to thank Aerographers Keeler, Highlands, and Garczynski for the dial switching every six hours, and Electronic Technician Vanatta for the installation of the three-pole switch.

REFERENCES

1. I. A. Singer, R. M. Brown, "The Annual Variations of Sub-Soil Temperatures About a 600-Foot Circle," *Transactions, American Geophysical Union*, vol. 37, No. 6, Dec. 1956, pp. 743–748.
2. Norman S. Benes, "Inside Antarctica No. 4—The Hallett Story," *Weatherwise*, vol. 12, No. 5, Oct. 1959, pp. 200–205.

Weather Note

UNUSUALLY WIDE TORNADO PATH

DANSY T. WILLIAMS AND JOEL J. WOODSIDE

U.S. Weather Bureau, Kansas City, Mo.

[Manuscript received May 6, 1960]

On April 15, 1960, between the hours of 1730 and 1830 CST a tornado traversed portions of Miami County, Kansas, and Cass County, Missouri. The purpose of this note is to describe some features of the storm path revealed by a survey of the damaged area made on April 16 and 18, 1960. The survey was accomplished by traversing all roads in the area and observing the location of damage patterns relative to the roads.

The path of the storm is shown in figure 1 and some comments on specific observations along the path are given in the caption. Three noteworthy features of the overall 14-mile-long path are: (1) its meanderings, as shown by a range of directions from 210 to 280 degrees; (2) its apparent production by at least two storms, separated from each other by a distance of $\frac{3}{4}$ to $1\frac{3}{4}$ miles with an

overlap from west to east of about 2 miles; and (3) its unusual width, ranging up to a mile in the portion made by the first storm, up to 1.2 miles in the portion made by the second storm, and up to 1.4 miles across the overlapped area.

That the unusual width of the storm path resulted from more than one tornado was borne out by the testimony of several eyewitnesses who reported more than one funnel. Moreover, the width of the path, the general absence of total destruction, the abrupt shifting of winds at several points, and the discontinuity line between northerly and southwesterly winds along portions of the path suggest a circulation system larger than the individual tornado funnel. It appears that this storm may have been of the "tornado cyclone" type described by Brooks [1], the micro-cyclone type described by Williams [2], or the rotating mother cloud-tornado system described by Fujita [3].

A fuller report on the results of this storm survey is available in manuscript form [4].

REFERENCES

1. E. M. Brooks, "The Tornado Cyclone," *Weatherwise*, vol. 2, No. 2, April 1949, pp. 32-33.
2. D. T. Williams, "A Surface Micro-Study of Squall-Line Thunderstorms," *Monthly Weather Review*, vol. 76, No. 11, November 1948, pp. 239-246.
3. T. Fujita, "A Detailed Analysis of the Fargo Tornadoes of June 20, 1957," *Research Paper No. 42*, U.S. Weather Bureau, 1960, (in press).
4. Dancy T. Williams and Joel J. Woodside, "The Path of the Kansas-Missouri Tornado of April 15, 1960," manuscript report (available in U.S. Weather Bureau Library, Washington, D.C.).

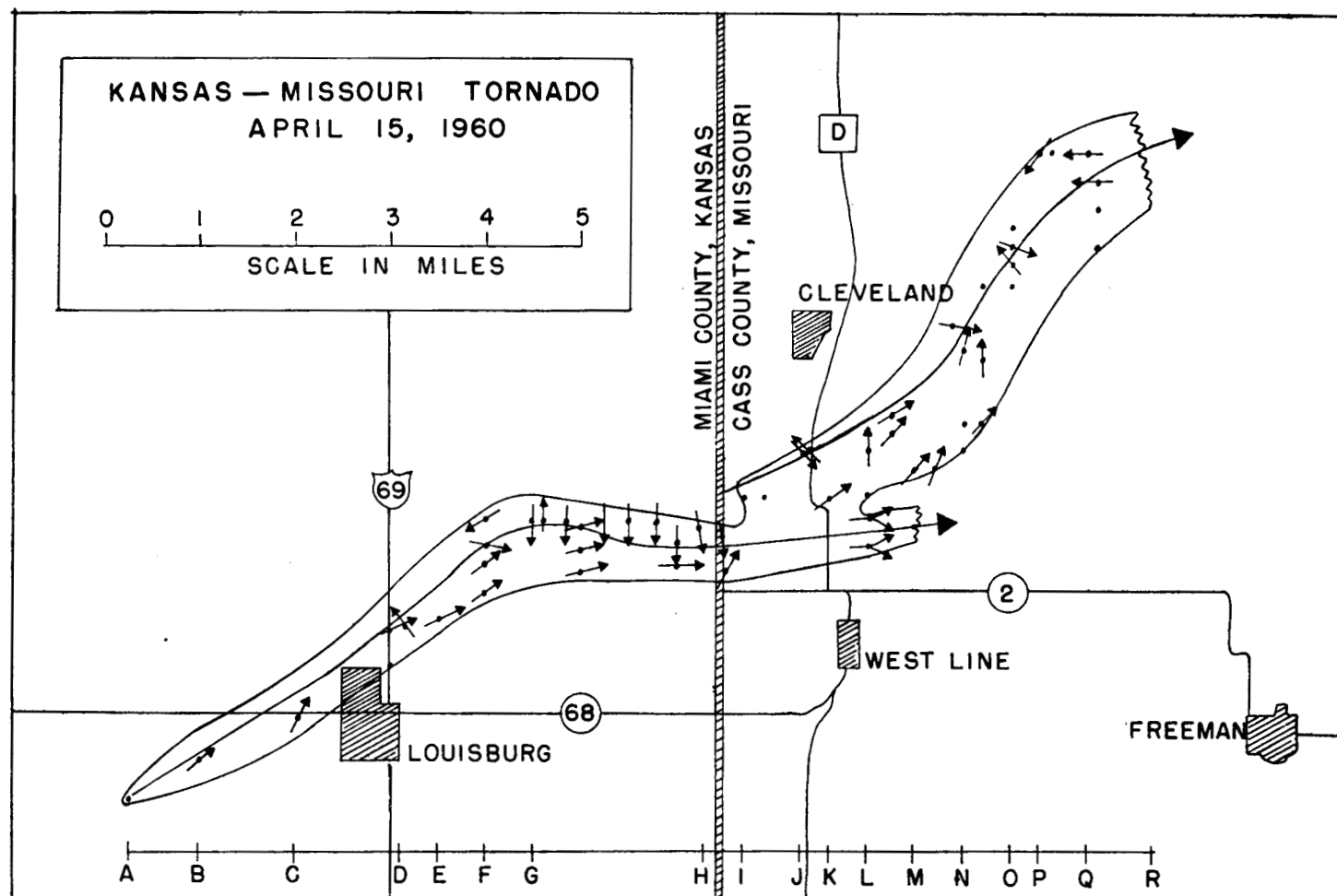


FIGURE 1.—Plot of the path of the storm of April 15, 1960. Damage was specifically noted at points marked by dots. If direction of damaging wind was apparent, it is indicated by a short arrow. Axes of the two overlapping storm paths are indicated by the long arrows. Specific observations, keyed according to the letters along the scale at bottom of figure, were:

- A—Very minor damage. Apparent beginning of the first tornado.
 B—Minor damage. Chickenhouse tipped over.
 C—Telephone lines damaged. Highway Department building destroyed.
 D—Major damage to farm buildings. First evidence of other than southwesterly winds. Damage caused first by southeasterly, then by westerly winds in time interval of a minute or longer. A threshing machine tipped over to the west. Debris of one outbuilding was carried to the northwest. House windows and doors blown open from within, suggesting pressure differential. Electric clock stopped at 1750 cstr. Three funnels observed, the last two merging into one.
 E—Damage to a north-south line of trees.
 F—Southwesterly winds to right, northwesterly winds to left of path.
 G—Major damage to farmstead; damage from southerly wind preceded damage from northerly wind. Storm track reached width of 1 mile, and direction turned abruptly from southwest to east.
 G to H—Definite discontinuity between damage due to northerly

- winds and southwesterly to westerly winds. Track of storm from west to east.
 I—Apparent beginning of second tornado $\frac{3}{4}$ mile north of track of first tornado.
 J—Along track of second tornado, wind shifted from southeasterly to northwesterly with damage from both directions.
 K—Major damage to trees by winds primarily from southwest, apparently part of circulation of second tornado.
 I to K—Virtually no damage along path of first tornado.
 L—West wind damage along path of first tornado but with marked scattering of debris to southeast through northeast. The overlapping of the two paths gave total width of 1.4 miles.
 M—Apparent end of first tornado; easternmost point of damage.
 L to N—Widening of second tornado path. General southerly to southwesterly wind.
 O—Definite discontinuity between southeasterly and northwesterly winds.
 P—Northeasterly wind on extreme left edge of path.
 Q—Easterly winds in northern portion of path; wind direction not apparent in southern portion. Path reached width of 1.2 miles.
 R—Apparent end of second tornado; easterly winds.